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Case report

Use of combined Taylor Spatial Frame (TSF) and Ilizarov for delayed treatment of femoral shaft fracture presented 6 weeks after injury—A case report

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1. Introduction

Surgical treatment of femoral shaft fractures is considered the gold standard in the last decades. The surgical treatment options continued to evolve over the last century. Internal fixation as well as external fixation options has been proposed. Each one has its advantages and disadvantages. The internal fixations options include surface fixation (conventional plates, locked compression plates) or intrameduallary nailing. Internal fixation is considered the standard of the care in management of femoral shaft fractures.[16]

The external fixators as a definitive treatment for femoral shaft fractures have few indications. The open fractures, severe soft tissue injuries with extensive contamination, evolving muscular crush that requires an extensive secondary debridement, medullary contamination, associated vascular injury requiring stabilization before repair, poly-trauma or injuries that prevent other treatments; comminuted, juxtarticular fractures are ideal for definitive treatment with external fixator.[16] External fixators can be also applied temporary as staged reconstruction protocol in fractures with bad soft tissue coverage in isolated shaft fractures or as part of the damage control orthopaedics in poly trauma patients. The proper timing of surgical treatment of fracture is essential for successful outcome femoral shaft fractures. The proper timing depends on several factors[19] including fracture and patients' factors. This article aimed to report a case of neglected femoral shaft fractures treated with combined TSF and Ilizarov ring fixators to achieve deformity correction and fracture healing as definitive treatment.

1.1. Case report

Eighteen years male patient sustained motor cycle accident. The patient had ipsilateral open grade III B tibial shaft fracture and closed short oblique femoral shaft fracture, junction upper and middle 1/3. The tibial shaft fracture was treated with Hoffaman's external fixator. The patient was kept on Thomas' splint for femoral shaft fracture. No other associated injuries were encountered. The patient presented to 1st author 6 weeks after injury. The reasons for delay of treatment were unclear but bad initial condition of the tibial wound, limited operative time and seeking for financial support from the government to support the treatment costs might be possible causes. After thorough study of the preoperative radiographs, the author decided to use combined TSF/Ilizarov to avoid disturbance fracture healing by open approaches and to accurately correct the deformity. The combined TSF/Ilizarov were used as definitive treatment to achieve fracture healing as well. The deformity analysis of the preoperative radiographs showed limb length discrepancy (LLD) of 70 mm, translation and angular deformities (recurvatum and varus) in both the sagittal and coronal planes. Extensive callus was observed around the fracture ends (Fig. 1). There was no rotational deformity.

1.2. Surgical technique

The patient positioned supine on radiolucent table and anaesthetized with regional anaesthesia through epidural catheter. The catheter used as adjuvant post operative pain control. Bump was put underneath the sacrum for thigh clearance during frame application. The patient was prepped and draped in the standard fashion. The author used ring first technique without preoperative frame preconstruction. The frame mounting composed of two Ilizarov half rings connected with threaded rods as distal block and two proximal arches connected together with 6 cm sockets as proximal block. Reference wire inserted parallel to the knee joint line and the position confirmed with intra-operative radiograph. After confirmation of the position of reference wire, additional 6 mm conical non hydroxyapetite half pins was added. A total of 5 half pins distally were applied with one half pin applied medially. The frame was mounted carefully orthogonal to the distal femoral segment for future TSF application. The orthogonal position of the distal block was confirmed with intra-operative radiographs in both frontal and sagittal planes. Five 6 mm half pins were also applied proximally and attached to arches. After finishing the frame application, two TSF (Smith and Nephew, Memphis, TN©) 2/3 rings (205 mm) were applied. The distal 2/3 ring was open posteriorly to allow knee motion during treatment whilst the proximal 2/3 ring was open medially for medial thigh clearance. TSF rings attached to Ilizarov rings were attached

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Fig. 1. Preoperative radiographs of femoral shaft fracture showing extensive callus around fracture ends as well as typical deformities of femoral shaft fracture.

proximally and distally using sockets. TSF struts were attached to the rings. TSF rings were considered as dead frame (Fig. 2). Postoperative radiographs were done orthogonal to distal rings. The web based TSF software was used for calculation of the correction schedule. Distal reference was used with 60° rotatory frame offset. Deformity and mounting parameters as well as the hardware parameters were provided to TSF computer software. Correction schedule was printed out and given to the patient. The distraction rate was 9 mm/day for deformity correction and equalization of LLD. We used total residual programme as correction mode. A total of three programmes were necessary to achieve full correction of the deformity. The correction was

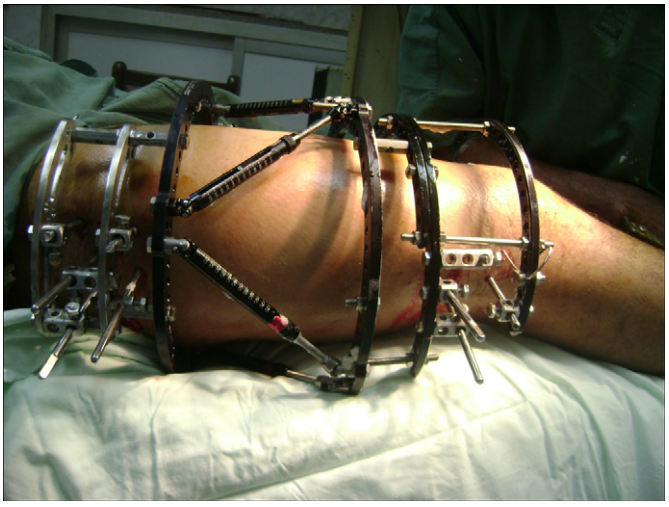

Fig. 2. The intra-operative clinical photo showing the combined TSF and Ilizarov. The TSF was considered as dead frame.

achieved within two weeks (Fig. 3). Strong pain medicines were necessary during correction due to rapid distraction rate. Despite rapid distraction rate, there were no serious complications with respect to nerve symptoms or muscle contractures. All aspects of the deformity were corrected accurately and confirmed with follow up radiographs. After correction of the deformity, TSF rings were removed in the office and threaded rod and 4 oblique supports were attached to arches proximally and the rings distally (Fig. 4). Post TSF removal radiographs confirmed maintenance of reduction. Local pin sites care was emphasized during the whole treatment. Superficial pin sit infection of the proximal half pins was controlled with oral antibiotics. Monthly follow up radiographs was arranged to monitor the fracture healing. Ilizarov frame removal was done in the operating room through short sedation. The radiographs at final follow up showed complete fracture healing and deformity correction (Fig. 5). The external fixator time between frame application and removal after fracture healing was three months (90 days). Non weight bearing with crutches after frame removal was allowed to avoid fracture through pins sites. Fig. 6 showed complete fracture healing 14 months after injury.

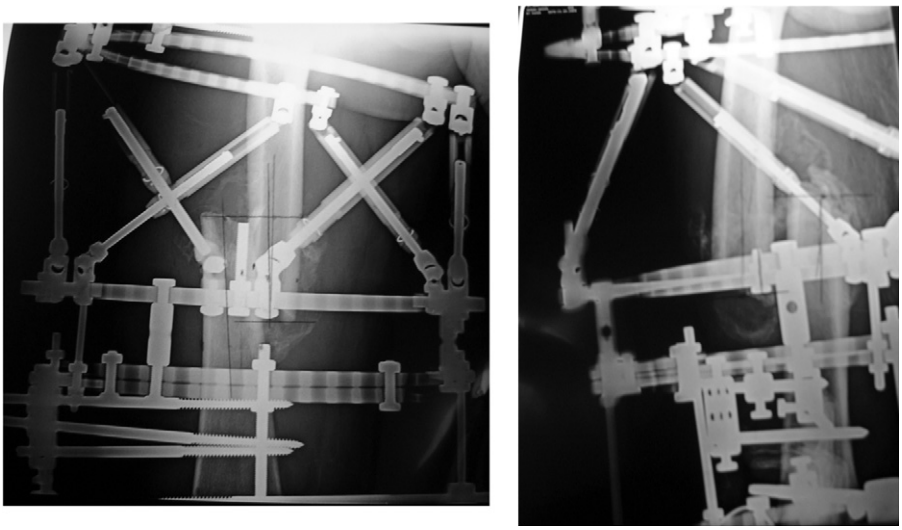

Fig. 3. The follow up radiographs during deformity correction.

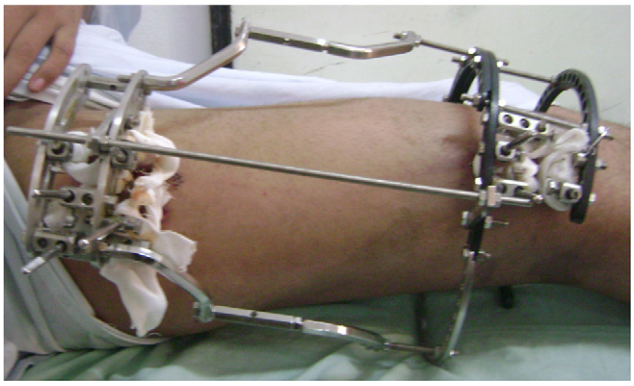

Fig. 4. The clinical photo after TSF removal.

Tibia external fixator was removed and patellar tendon plaster of Paris (POP) walking cast applied. Tibial fracture healed six months after injury. Although knee exercises were strongly instructed to the patient, there was limitation of the knee range of motion during frame application. During frame removal, the knee was passively and gently manipulated under general anaesthesia to improve the range of motion. Residual knee stiffness was managed latter with physical therapy. At final follow up, the patient was able to bend his knee from 0 to 90 (Fig. 7).

2. Discussion

The natural history of femoral shaft fractures is displacement with angular, translational and rotational deformities as well as limb length discrepancy (LLD) secondary to strong muscle pull around the femur.[19] The purpose of this article is to report a case of femoral shaft fracture presented 6 weeks after the injury and treated with combined TSF and Ilizarov. The initial radiographs showed extensive callus reflecting excellent healing potentials of the patient as well as typical deformities of untreated femoral shaft fracture. This kind of injury can be treated using several surgical treatment options including both internal fixation and external fixation techniques. Although all internal fixation options could be applied for this case, all these options require open reduction and strong distraction to correct LLD and angular/translational deformities. Open reduction and internal fixation are associated

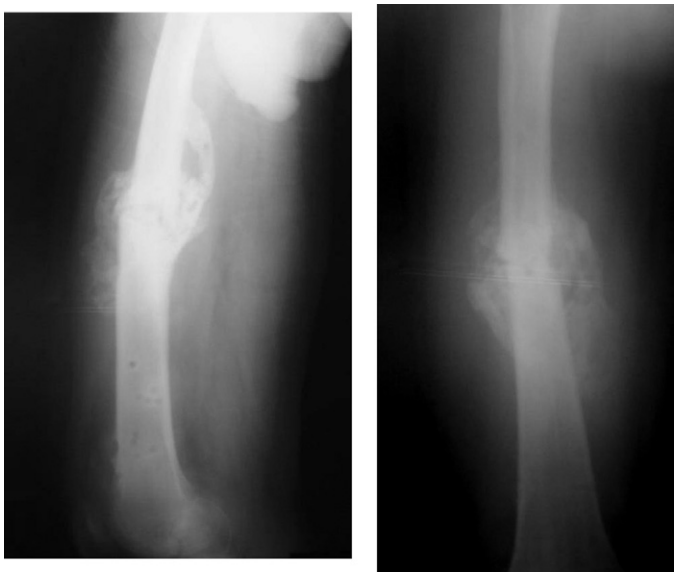

Fig. 5. The final radiographs after frame removal showed deformity correction as well as fracture healing.

Fig. 6. The last follow up radiographs 14 months after frame removal showing complete fracture healing.

several disadvantages. These included disturbance of the fracture healing, blood loss due to extensive exposure of the fracture ends, infection risk, the need for autogenous bone graft (ABG), risk of implant failure, the need for hardware removal. ABG can be associated with of donor site morbidity.

Fig. 7. The clinical photo showing the knee range of motion 6 months after frame removal.

The combined TSF/Ilizarov used as definitive treatment in this case because of its many advantages. First, as biological method it avoided disturbance of the fracture healing. Second, TSF web based computer program is accurate in achieving reduction and deformity correction without extensive exposure of the fracture ends. In this case, there were no residual deformities or LDD at the end of treatment. The reasons for using for the combined TSF and Ilizarov technique were: first the author's institute had limited access to TSF. The combined technique was used to take the advantages of the accuracy of TSF and availability of Ilizarov parts in author's institute. This allowed the author to use recycled TSF frames in many patients with the potential benefits of containment of health care costs which is an important issue especially in developing countries.[7,17,10] Second, Ilizarov was less cumbersome and lighter to the patient than TSF. Third, Ilizarov's four threaded rods allowed better radiographic evaluation of fracture healing in comparison to TSF six struts. Although the combined TSF/Ilizarov frame was cumbersome initially, it was generally well tolerated. This treatment technique avoided the patient open reduction approach with potential risks of blood loss, infection as well as the need for ABG. Although the author was very concerned about risk of inability to distract the fracture ends due to extensive callus formation, the author decided to give the patient the chance to distract without releasing the fracture ends and if this failed, the author was prepared to release the fracture ends to achieve correction. The complications were grade 1 pin tract infection of two proximal half pins which was controlled with oral antibiotics and limitation of knee motion.

This case showed the ability of combined TSF/Ilizarov in achieving deformity correction as well as fracture healing with external fixator as definitive treatment.[12,15,14,21,13] This case emphasized the importance of proper timing of surgical treatment femoral shaft fractures as well. Delay in initiation of the treatment may have bad outcome and poor patient's satisfaction. The choice of proper time for surgical intervention for femoral shaft fracture depends on multiple factors.[19]

The accuracy of TSF in correction of skeletal deformities had been reported by several authors.[12,15,14] Maragnoz et al.[12] reported 22 femoral deformities in 20 patients treated with TSF. The mean age at surgery was 13.9 (5.9–24.6 years). Deformity correction in all planes as well as equalization of LLD was achieved in all patients.

Healing of femoral shaft fractures can be achieved using external fixators as definitive treatment.[13,4–6,9,3,1,20,18,2] Reported union rates with definitive external fixators are variable in the literature between 70–100% with higher rates in closed fractures in comparison to open fractures.[21]

Neglected femoral shaft fractures are rare injuries and reports in literature are very few.[11,8] Mahaisavaria et al.[11] described 14 cases of neglected femoral shaft fracture treated with open nailing. The authors used only local ABG from local callus. The average age at surgery was 28 years (range 17–50). The mean time of delay of treatment was 4.6 months (range 2–10 months). All fractures healed within 3 months (range 2–4 months). The authors reported limitation of knee motion in 8 patients whilst the other 6 had full range of motion. Gahukamble et al.[8] reported 11 patients with neglected femoral shaft fractures treated with open nailing augmented with iliac crest bone graft if local graft was not sufficient. The average time of delay was 14 weeks (range 3–32 weeks). The authors added manipulation of the knee during anaesthesia to improve the knee range motion postoperatively. The complications were patellar tendon rupture in one patient and delayed union in another one.

Being a case report and the need for further studies to prove the efficacy of combined of TSF/Ilizarov for neglected femoral shaft fractures over other methods are the main study limitations.

In conclusion, external fixators are useful technique for treatment of neglected cases of femoral shaft fractures. It avoids the need for open approaches with their potential complications. The combined TSF/Ilizarov technique combines the accuracy of TSF and availability of Ilizarov parts. It allows deformity correction as well as fracture healing as definitive treatment.

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